Trajectory Specification for Air Traffic Control
Format for Communicating Aircraft Trajectory Requests and Assignments

The system deployed in this technology will be used for communicating trajectory information between an aircraft and one or more ground systems.

In the current air traffic management system, the fundamental limitation on airspace capacity is the ability of human air traffic controllers to maintain safe separation with high reliability. The increase in airspace capacity that will be needed over the next few decades will require that separation be at least partially automated. Standardized four-dimensional trajectory assignment will be needed to accomplish that objective. A trajectory specification format based on the Extensible Markup Language is proposed for that purpose. This format can be used to downlink a trajectory request, which can then be checked on the ground for conflicts and approved or modified, if necessary, then uplinked as the assigned trajectory. The horizontal path is specified as a series of waypoints connected by great circles, and the great-circle segments are connected by turns of specified radius. Vertical profiles for climb and descent are specified as low-order polynomial functions of along-track position, which is in turn specified as a function of time. Variable flight technical error tolerances in the along-track, cross-track, and vertical axes define a bounding space around the reference trajectory, and conformance will guarantee the required separation for a specified period of time. The error tolerances could be a function of traffic density, with potentially looser tolerances in sparse traffic. An important safety benefit of this regimen is that the traffic will be able to fly free of conflicts for a specified period of time (at least several minutes) even if ground-based ATC systems and the communication infrastructure fail. Periodic updates will adjust for errors in the predicted along-track winds.

Technology Background

Use of a four-dimensional description of an aircraft trajectory, involving three Cartesian coordinates (x, y, z) and elapsed time t, was proposed in 1972 by H. Erzberger and T. Pecsvaradi ("4D Guidance System Design With Application To STOL Air Traffic Control", 13th Joint Automatic Control Confer., Stanford, Calif. Aug. 16-18, 1972, pp. 442-445) and has been considered by many other workers since then. One potential problem with specifying altitude as a function of time is that along-track error couples into altitude (and could, in an extreme case, require a flight to land ahead of or behind its designated runway). In the current approach, altitude is specified correctly as a function of along-track position. The current approach also helps to maintain safe separation for a longer period of time in the case of a failure of a ground-based air traffic management (ATM) computer, thereby preventing an abrupt transfer of responsibility for safe separation of traffic onto human air traffic controllers (ATCs). One ultimate goal of an automated ATM system is to remove, or minimize reliance on, ATCs from active participation in maintenance of separation between aircraft.

What is needed is a method and system for specification of an aircraft trajectory in terms of coordinates that allow use of higher capacity of traffic in a given volume of airspace, define bounds on allowable along-track, cross-track and vertical errors, and compensate for deviations from a time schedule so that an aircraft is not required to fly with unrealistic velocity or unrealistic angle parameters. The approach should allow for in-flight changes in flight parameters to take account of a changed environment.

Patents

This technology has been patented (U.S. Patent 7,650,232).

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for Trajectory Specification for Air Traffic Control for commercial applications.

For More Information

If you would like more information about this technology, please contact:

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